**Skin Temperature Analysis and Bias Correction in a Coupled Land-Atmosphere Data Assimilation System**

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***Abstract***

In an initial investigation, remotely sensed surface temperature is assimilated into a coupled atmosphere/land global data assimilation system, with explicit accounting for biases in the model state. In this scheme, an incremental bias correction term is introduced in the model's surface energy budget. In its simplest form, the algorithm estimates and corrects a constant time mean bias for each gridpoint; additional benefits are attained with a refined version of the algorithm which allows for a correction of the mean diurnal cycle. The method is validated against the assimilated observations, as well as independent near-surface air temperature observations. In many regions, not accounting for the diurnal cycle of bias caused degradation of the diurnal amplitude of background model air temperature. Energy fluxes collected through the Coordinated Enhanced Observing Period (CEOP) are used to more closely inspect the surface energy budget. In general, sensible heat flux is improved with the surface temperature assimilation, and two stations show a reduction of bias by as much as 30 $Wm^{-2}$. At the Rondonia station in Amazonia, the Bowen ratio changes direction in an improvement related to the temperature assimilation. However, at many stations the monthly latent heat flux bias is slightly increased. These results show the impact of univariate assimilation of surface temperature observations on the surface energy budget, and suggest the need for multivariate land data assimilation. The results also show the need for independent validation data, especially flux stations in varied climate regimes.

***Popular Summary***

Surface temperature is a critical component of Earth system. It is the lower boundary of the atmosphere, and estimates how much the surface is heating the atmosphere from below. Remote sensing of atmospheric data from space also uses surface temperature as an important condition. In this paper, we use remotely sensed surface temperature over land in a coupled land/atmosphere data assimilation system. Data assimilation is the process of merging observations and model simulations to combine the consistency of model simulations with the accuracy of the observations into one data product. The resulting assimilated surface temperature should be a better data set than without the data assimilation, but also, the processes that relate to surface temperature (such as warming of the atmosphere) should be better represented.

The method implemented here, allows for the assimilated surface temperature observations to directly affect the heat fluxes that occur at the land surface. Previous methods do this indirectly through the near surface air temperature or moisture in the soil. We have performed several experiments to evaluate the assimilation of land surface temperature. The first corrects the mean bias of the assimilation system and the second corrects biases in the diurnal (or daily) cycle of temperature. We show that by correcting only the mean bias, additional errors can be introduced in the daytime high temperatures and nighttime low temperatures. The diurnal assimilation improves both the mean air temperature as well as the high and low temperatures.

In further validation of the method, we use enhanced observations of the surface heating from several in-situ stations. Indeed, the assimilation of remotely sensed surface temperature did improve the surface heating of the atmosphere. However, the heating of the atmosphere due to the phase change of water from liquid to gas (evaporation) was slightly degraded when including the surface temperature assimilation. This is partly because the surface soil water is not constrained by observations and may have its own bias. We expect that remotely sensed soil moisture observations would greatly improve this component of the atmospheric heating.